DOCUMENT RESUME

ED 308 818 IR 013 878

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TITLE A Review of the Research on Interactive Video.
PUB DATE Feb 89
NOTE 22p.; In: Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology (Dallas, TX, February 1-5, 1989). For the complete proceedings, see IR 013 865. For related papers, see IR 013 873-877.
PUB TYPE Information Analyses (070) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Affective Measures; *Cognitive Style; Cost Effectiveness; Economics; Instructional Design; *Instructional Effectiveness; *Interactive Video; Learning Processes; *Media Research; Psychological Studies; Research Design

ABSTRACT

This review of the literature on interactive video examines research and evaluation reports in the context of the continuing debate over the effectiveness of media debate and Richard E. Clark's argument that media do not have a substantial impact on learning. The literature is examined from four perspectives: (1) behavioral issues (e.g., whether videodisc based programs have helped teachers achieve high levels of student mastery for large and diverse classes); (2) cognitive issues (whether media can activate mental skills); (3) affective issues (whether a learner has a particular preference for a type of medium and how much effort he/she has to invest in order to learn a particular task); and (4) economics and cost-effectiveness (what kind of cost-effectiveness studies can be conducted to examine the role of interactive video in increasing learning efficiency). It is noted that Clark is viewed as being accurate in suggesting that the wrong questions are being addressed in terms of the effectiveness of interactive video. Concluding remarks point out that the literature indicates that new variables are being researched in media comparison studies that might result in more generalizable findings; that the promise for future media research lies in using interactive video as a research tool; and that the need exists to conduct evaluation studies on the medium itself in order to optimize its features and capabilities. Three tables are appended which summarize some of the principal research that has been done on interactive video to date. (39 references) (CGD)

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Symposium: Interactive Video Symposium: The Singer or the Song-- An Extension of Clark's Media Research Discussion

Paper #5: A Review of the Research on Interactive Video

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A Review of the Research on Interactive Video

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Introduction

Richard Clark's article, *Reconsidering Research on Learning from Media.* (1983), focused our attention on the effectiveness of media debate. Clark argued convincingly that media do not have a substantial impact on learning. This sentiment has been echoed by others including Clark and Angert (1980) who argue that "media researchers tend to operate within a vacuum and rarely acknowledge research investigations and results in parallel interests in other fields" (Moore, 1986, p. 190). Since the debate first emerged, one of our latest technologies, interactive video, has continued to grow in use. In considering the media comparison argument, it is useful to examine research on interactive video. The literature on interactive video can be classified according to four categories: reports of uses, descriptions of features and capabilities of interactive video, suggestions for design (Braden, 1986), and research and evaluation reports (Cushall, 1987). This paper focuses on research and evaluation reports.

In order to locate studies to be included in this review, a number of methods were employed. In addition to a search of ERIC documents and Psychological Abstracts from 1985 - 1989, working papers were solicited through faculty contact. The studies selected for inclusion in this paper meet the following criteria: (a) All reports included pertain to research or evaluation with interactive video. Research on computer-assisted instruction (CAI), although related, is not reviewed in this paper. (b) All studies included reported some form of data. The final selection of articles included both published and unpublished sources, with the intent of avoiding a publication bias.

Articles concerned with reports of uses or capabilities of interactive video, or with broad conclusions that failed to present data, were excluded from this paper. Readers interested in a broad review of interactive video are referred to excellent articles by Smith (1987) and Bijlstra (1988). In addition, interactive video research reported from 1980 - 1984 has been reviewed by Bosco (1987).

In their recent review of the literature on media, Clark and Sugrue (1988) analyze the trends and identify areas for future research. What are researchers studying with interactive video and where do we stand in terms of Clark's media comparison argument?

Clark and Sugrue (1988) have separated the literature into four basic areas. This paper examines interactive video studies according to the same categories: behavioral issues, cognitive issues, attitudinal issues, and economic issues. The first section reviews the studies that can be categorized as investigating variables in a behavioral paradigm. The next section details what variables have been investigated according to a cognitive perspective. The third section examines what has been learned from the investigation of variables in the affective domain.

Finally, the last section reviews studies which were concerned with economic issues. The tables appended to this paper include information on the principle investigator, subjects, content area, sample size, and variables explored for each of the articles or papers reviewed. This is similar in format to a review on interactive video reported by Bosco (1986).

Behavioral Issues

Clark and Sugrue propose that there has been a "paradigm shift" in media research from a behavioral orientation to a cognitive orientation. Is this evidenced in the research conducted with interactive video?

While there has been a shift, there are still a number of media comparison studies where interactive video is compared with some other type of medium (see Table I) such as computer based instruction or traditional lecture format. Interactive video has been compared to traditional computer based instruction, traditional lecture, non-interactive video, print based material, and laboratory exercises. Generally, instruction between two types of media are compared and effectiveness is defined as a score on a retention or achievement test. While many of these studies report the superiority of the interactive video medium over the comparison, close inspection verifies what Clark has said since he first presented his media comparison argument in 1983, the "active ingredient is usually some uncontrolled aspect of the instructional medium" (p.23, 1988). Rarely does one hear mention that the instructional method or content differences may account for the seeming superiority of interactive video.

For example, Peterson, et al (1988) asked whether videodisc-based programs help teachers achieve high levels of student mastery for large and diverse classes. They studied all of the fifth grade classes in Logan, Utah (n=11) on a level one application of interactive video and pre/post tested the students on embedded unit mastery tests. The posttest mastery scores were at the 70%. In addition, scores on the CTBS were compared to the previous year's CTBS test scores and general improvement was cited. In conclusion, the authors highlighted the ease of use of the videodisc and felt that its use contributed to the gains in the CTBS scores as compared to the previous year when only "traditional instruction" was offered. It seems that this study is lacking in validity in a number of ways. That is, how do the individual modules correlate with the CBTS test items? Is 70% mastery significantly better that what the mastery would be, given instruction in the traditional sense? The specific planning involved in the design of the level one application may have accounted for the variation in the test scores. Also, with small sample sizes which are typical of the interactive video studies reviewed, findings are not generalizable.

When one is examining the effects of different media, everything except the media compared must be the same, including instructional methods employed and content. While content generally is held constant in these media comparison studies, the instructional methods employed are not. Malouf et al (1986) tried to control instructional methods in a study comparing interactive videotape and workbook instruction of on-the-job skills for mildly handicapped teenagers. In order to match the two media as much as possible, each of the instructional activities in the videotape had a parallel activity in the workbook. Also, a single instructor delivered both treatments. While the videotape treatment was found to be superior, Malouf acknowledges the confounding effect of novelty due to the brevity of the treatment.

I would like to suggest that there are reasons that the instructional methods employed are not held constant. Often, the media comparison study examines already prepared lessons, or at best, one prepared lesson and one lesson specifically designed for research purposes. If we were not so quick to utilize existing discs, we might be more careful in our design of instructional methods for the treatments.

Often, and I have experienced this myself, one is presented with an opportunity to "repurpose" a disc for the purposes of research. Now, one might know that a number of examples need to be presented for the learner to fully grasp the content, however, if there are just three pieces of video footage on the disc appropriate for examples, one compromises knowledge about instructional strategies for the purpose of designing and conducting the research study. It is difficult to teach a principle, for example, with only three examples. However, a "fact" level lesson might be constructed with just three examples--and there we have a "compromise" in terms of our research design. If we are going to repurpose discs for the purpose of research, we should at least use some of the guidelines that have been suggested in the literature (Allen, 1986).

Perhaps the continued existence of media comparison studies is not too surprising when one considers that many of these studies are commissioned by the producers of the interactive videodiscs or the hardware who are looking for justification that their method is "right." Do we really need to compare in order to justify? In many instances it seems that it would be more appropriate to evaluate with the purpose of optimizing one particular medium. This is especially true because media are often pre-selected. Fortunately, the recent research studies conducted with interactive video have shifted toward exploring cognitive variables.

Cognitive Issues

Another of Clark and Sugrue's categories is that of cognitive issues. In the studies examined for this paper, there is reference to these cognitive issues but there are rare accounts of studies which have been conducted in order to quantify or understand some of the cognitive issues. For example, can media activate mental skills? Clark and Sugrue (1988) suggest that "future media research would do well to ask not just whether particular skills are acquired but also, how else they could be developed, and under what instructional, contextual, and psychological conditions they can be made to transfer." p. 29. Many studies have examined interactivity, feedback, and practice. While these variables could be classified as elements of instructional strategies rather than cognitive variables, typically the researchers have been interested in the effects of these variables on information processing which results in learning. For example, does increasing the 'interactivity' enable learners to process information more effectively, and affect how much information is retained?

A few of these of studies will be described here. Additional studies are included in the table appended to this paper (see Table I). Results from a study conducted by Hannafin, Phillips, and Tripp (1986) suggest that the availability of orienting activity affects both the type and amount of learning. Students given an orienting activity performed best under reduced time while students who were not provided with orienting activities performed best with extended time. There were interactions between orienting activities and processing time, suggesting that neither element alone affects learning. This is an example of a study that uses interactive video as a research tool. One can imagine a similar study conducted without an interactive videodisc and replications of these results could be generalized to a variety of learning situations.

In addition to orienting activities, the influence of practice for different types of learning has been investigated and the results are not uniform. In an investigation conducted using interactive video (Hannafin & Colamaio, 1986), practice was found to be important for the learning of declarative knowledge and problem solving skills, but of little effect for procedural knowledge. A later study conducted by Hannafin, Phillips, and Tripp (1986) investigated the effects of practice and processing time on learning. Their subjects were 80 volunteer college students. The practice items consisted of two multiple choice questions (one fact, one application). The posttest consisted of 32, five part multiple choice questions. One-half of them (eight fact, eight application) were practiced during the lesson and the remaining 16 items were new items. Practice resulted in favorable results only for the *facts* where test scores more than doubled the scores for non-practiced items (90% correct to 44%). However, test items at the application level were unaffected by practice.

One concern about these types of studies is whether or not they employ an adequate lesson format. The National Gallery of Art Tour has been adapted for the purposes of many of these studies (Hannafin, Phillips, and Tripp,1986; Hannafin & Colamaio, 1986; Jonassen,1987; Phillips, Hannafin, and Tripp, 1988). One wonders whether there are even sufficient numbers of examples and practice items present in these sequences of instruction, since the lessons are adapted from the existing tour. If the practice is simply rehearsal, then it is not surprising that the results showed practice to be effective for facts only, and not application exercises. This finding was also consistent with the earlier Hannafin & Colamaio (1986) study. If we accept the conclusions as given, the insertion of interactions in a lesson in the form of practice might not be relevant for the application level of learning performance, as this study demonstrated. However, this is in contradiction to most of the research on Component Display Theory (Merrill & Tennyson, 1977).

While some features of interactive video may be desirable for reasons other than learning effectiveness (i.e. attitudinal impact), the Hannafin and Colamaio (1986) study suggests that there may be limits to the effects of the interactions (in this case, practice). In terms of interactive video, this could mean that maximizing the capabilities of branching has little effect on learning. If these results were analyzed from a cost effectiveness point of view, many interactions would be unnecessary, and a waste of time. Of course, "practice" needs to be investigated more before such conclusions are drawn and interactive video as a research tool might be extremely helpful in this regard; however, the typical treatment would have to be revised radically.

A related study (Phillips, Hannafin, and Tripp, 1988) looked at practice and orienting activities on learning from interactive video. Seventy-two college students were randomly assigned to an orienting group and to one of three practice groups: No practice, Limited practice, or Elaborate practice. The lesson included both fact and application level learning of concepts in art. Students were measured on a posttest which consisted of 16 new and 16 repeated items for facts and applications taught during lesson. The means between the three groups were only found to be significant on the *repeated items*. There was not a significant difference between the different types of practice on the test items which were not included in the lesson. The orientation activities themselves did not contribute to learning as measured in this study.

This study warrants special consideration. It is not surprising that there was a significant effect of elaborate practice on the retention of the repeated items. The authors were trying to measure the effects of practice on two different performance levels: fact and application, however, the inclusion of so many repeated items reduces the experiment to a measure of pure recall. In order to test the effect of

practice on application level learning, the lesson should be redesigned to include *new instances* at the test level.

I suggest that we advance our design of the lessons that we employ when investigating interactive video. Some of the features of interactive video would be especially helpful in the investigation of instruction at the principle or procedural level; however, it would entail additional design time and possibly, the creation of discs for the specific purposes of research.

Jonassen (1987) investigated the effect of practice on prototype development in a concept lesson in art history, utilizing the National Gallery of Art disc. Thirty college students participated in the study which measured (a) prototype only, (b) prototype and practice, and (c) prototype, elaboration and practice. The *prototype only* treatment presented the name of the style of art, plus three examples. The *prototype and practice* presentation was the same as the prototype only treatment, except that there were ten additional practice items and knowledge of results were provided to the learner. The *prototype and elaboration and practice* presentation was identical with the previous treatment except that it included an imaging strategy. Students were asked to close their eyes and imagine three characteristics of that type of painting and type their answers into the computer. This required the most elaborate practice (or in this case, "active processing") by the learner. The results showed that the prototype only group differed significantly from the other two groups on the posttest scores. However, there was not any difference between the *prototype and practice* and *prototype, elaboration and practice* groups.

It is difficult to determine whether or not the subjects performed the mental rehearsal strategy and to what extent they did. If in fact they did, and if the results could be replicated with a larger sample size, this study might provide evidence that additional practice in the form of mental rehearsal can be unnecessary for concept level learning. However, a study which examined principle or procedural learning might determine that mental imaging is important in far transfer for these levels of learning.

Basically, we are making progress in the pursuit of investigating cognitive issues with interactive video as a research tool. Our weakness seems to be in the actual lesson design of the discs employed to investigate the various variables. As studies improve in this regard, we should be able to investigate learner differences and processing variables. In addition, the features of CBIV would enable us to examine research questions concerning procedural learning, principle learning, generic skills, and instructional strategies.

Affective Issues

Motivation theory answers not only, "Did I like it" but whether the task is enjoyable, what skills are required to learn from the task, and do I have the skills I need to learn from the task? These questions refer to not only whether a learner has a particular preference for a type of medium but also to the amount of effort that will have to be invested in order to learn from a particular task. The research in this specific area is sparse. However, many of the studies in the literature report some measure of preference such as 'the learners preferred the interactive video over traditional lecture' but this is usually a secondary measure whereas achievement is of primary concern. Clark and Sugrue (1988) urge researchers to measure engagement, levels of effort, perceived demand characteristics, and self efficacy.

Have any of these variables been studied with regards to interactive video? Not yet. While there have been reports related to values and attitudes, these are confounded because the intent of the study is usually to measure achievement. One recently reported study (Bosco & Wagner, 1988) assessed the attitude of auto workers toward interactive video as compared to classroom instruction with video tape. All workers received instruction in *both* formats and since both formats were new to the workers, the researchers felt that this would control for the Hawthorne Effect. Often, studies examining interactive video ask the subjects to report their preference to something that the subjects reflect back upon whereas this study investigated attitudes after *all* of the subjects experienced *both* treatments. The content area was instruction on the handling of hazardous materials. When workers reported on their attitudes toward interactive video as compared to the classroom and videotape instruction received in the treatment, they responded more favorably to interactive video. Thus, if one is in a situation where either type of training is available, this evaluation study suggests that workers prefer interactive video.

I include here a related study that might provide a future direction for research on media attributes and attitudes. A study conducted by Simonson, et al (1987) suggests that attitudes can be modified by using media to deliver messages, and that some types of media may be more effective than others in modifying attitudes. While the Simonson and his colleagues compared motion pictures and slide tapes, this might be an area for further investigation and one that could be researched using interactive video as a tool. This type of study moves away from the media comparison format of the past. If everything else is held constant, it might be that *motion* is an important consideration when providing visual images that lead to attitude change. If it were determined that one needs to get as close to realism as possible when designing instruction for attitude change, then interactive video might be the most appropriate choice when *mediated* instruction is desired.

Economics and Cost-effectiveness

Clark's media argument was criticized by Petovitch and Tennyson (1985), who pointed out that while some media may not be more effective than others in terms of learning, they might be more cost effective. Cost effectiveness is an important consideration because it is a variable that can contribute to the types of decisions many clients need to make when considering mediated instruction. However, results from economic studies will not provide insights into instructional theory. Still, they are an area for needed research.

There have only been indirect measures of variables that relate to cost-effectiveness issues. Learning acquisition rate was measured by Schaffer and Hannafin (1986) in a study that examined four video treatments which differed in amounts of interactivity. The four treatments were: linear video only, video with embedded questions, video with questions and feedback, and fully interactive video (video, embedded questions, feedback, and remediation through branching). Schaffer and Hannafin (1986) computed the amount of recall versus instructional time and called this ratio, *acquisition rate*. The linear video treatment had the highest *acquisition rate* score. The authors concluded that the most efficient use of time versus learning is the non-interactive linear video. However, the highest recall scores resulted from the fully interactive treatment. This study did not determine whether the increase in recall could be due to the increased length of instructional time. However, this study did demonstrate that for instructional circumstances requiring a great deal of recall, interactivity is well suited. Perhaps the most important question is not whether interactivity enhances learning but whether it does so *sufficiently* to warrant the increased instructional time, and whether in view of this time/cost consideration, it is a feasible medium

Finally, a number of articles (Smith and Dunn, 1987 and Peterson, et al. 1988) cite productivity gains due to the use of CBIV. Teachers report feeling less pressure and increased teacher-student interactions as a result of being freed from the more 'mundane tasks' of instruction.

The reader is referred to Levin (1987) and Levin, Glass and Meister (1985) for examples of the type of cost effectiveness studies that might be conducted, examining interactive video. Levin (1987) examined the cost-effectiveness of CAI, peer tutoring, reduced class size, and increased instructional time (number of days in school). CAI was found to be more cost effective that increasing instructional time or decreasing class size. Levin suggests that the time and effort needed to obtain a given level of learning efficiency will decline as the technology of learning resources improves. Students will "wish" to allocate more time to learning activities as their efficiency in producing learning rises relative to their efficiency in the production of learning activities. This is an area of research which could have direct implications for media selection decisions.

Conclusions

The analysis in this paper might leave the reader feeling that there is little to argue for the effectiveness of interactive video and that we haven't made much progress since Clark first presented his "mere vehicles" argument. In terms of interactive video, I agree with Clark and suggest that we are asking the wrong questions. While many of the reports included in this paper and the appended tables conclude with a statement about the effectiveness of interactive video, increasing numbers are reporting data relating to instructional variables. There is much to warrant the use of interactive video as a research tool. Specifically, its ability to combine video, audio, text, and motion, as well as its branching capabilities suggest that interactive video can be extremely useful for presenting and collecting data in a controlled way. We MUST re-orient ourselves toward conducting research on instructional strategies or affective variables that lead to formulating generalizable theory. In addition, an increased focus on the evaluation of interactive video discs and their uses would enable us to optimize the medium for particular situations, types of content, and types of learners. As Heinich (1984) as argued, the main purpose of media research is to improve rather than prove media"!

If we are oriented to this end, it is likely that the media comparison studies which attempt to link interactive video with specific learning gains will disappear completely. I will be happy if in ten years, when reviewing this body of research literature, I find no mention of interactive video until I reach the methods section of an article. There, perhaps in the fine print, will be a phrase such as, "interactive video was used to present the treatments and record the data."

This suggestion, that interactive video be used as a research tool, is not new (see, for example, Grabowski and Pearson, 1988) however, it has been underutilized. It is much easier to construct experiments using existing videodiscs. I have yet to read about a videodisc that was *specifically* constructed for the purpose of research. Yes, there are many discs constructed for particular courses via IV that have formative evaluation built in to the development process. Many of these evaluations have taken the form of quasi-experimental studies and some of the results have been reviewed in this paper and the appended tables. However, the results are intended to provide information specific to that particular program, not to generalizable theory about instructional design.

What can be done about this? Imagine the generic research disc that Jonnasen (1984) first described- one that had a host of instructional treatments, presentation forms, events of learning, generic skills. Such a disc might take a long time to develop and for the one shot treatment would certainly be inappropriate. However, once developed, a number of studies could be conducted with a host of samples. The lessons employed in the treatments would be designed in the "ideal", according to instructional design principles, not according to the need for a quick instructional

treatment to crank out some results. It has been difficult to evaluate the actual results of some of the studies reported simply because the format of the lesson is not fully described in the report. Is it a concept lesson, principle, etc? Is recall being measured again? Are we not beyond recall in our knowledge of prior research? This review of the literature on interactive video research demonstrates that while we have continued to conduct media comparison studies, we are beginning to research variables which might have more generalizable findings. The promise lies in using interactive video as a research tool. In addition, we need to conduct evaluation studies (see Reeves, 1986 for suggested models) on the medium itself, in order to optimize its features and capabilities.

Principle Investigator	Subjects	Subject Matter	n	Independent Variables	Dependent Variables	Results
Bosco (1988)	General Motors workers	hazardous materials	209	• level III interactive video disc • videotape	• achievement on posttest • opinion survey • user preference instrument to measure attitude	• subjects had higher achievement with IV • subjects tended to prefer IV but subjects exhibited positive attitudes towards both methods
Branck (1987)	Veterinary Students	heart auscultation	87	• videodisc & lecture • lecture only	• performance on practical exam	• video group more positive about learning • quality of videodisc rated good • no significant difference between the groups on the practical exam • video group began to listen only and not attend to video
Carter (1985)	mildly handicapped teenagers	budgeting	26	• brief feedback • extended feedback	• acquisition of concepts	• no significant difference in performance • interactive videodisc group exhibited less negative reaction to content
Dalton, D.W. (1986)	junior high	general shop safety rules	134	• video only • CAI only • interactive video	• performance • attitude	• CAI most effective • IV produced improvements in learner attitudes compared to CAI and video • attitude effects interacted differed across prior achievement level

Principle Investigator	Subjects	Subject Matter	n	Independent Variables	Dependent Variables	Results
Grover (1986)	adult	language & sociocultural infirmation	64	• interactive video • linear video	• content acquired • attitude changes • self reported behavior changes	• no significant differences between the two groups in terms of achievement and perceived difficulty
Hannafin (1986)	college	art	80	• achievement on posttest	• achievement on posttest	• practice found to be effective at the fact level; no effect for applications level
Ho (1986)	college & graduate	installing computer interface boards		• computer controlled review • learner controlled review • no review • objectives • no objectives • verbal info, concepts, rules	• achievement on posttest	• Both computer and learner controlled review found to have a signifcant effect on posttest scores. No difference between learner and computer controlled conditions • Learner controlled review significant for concepts only • Multivariate analysis did not produce significant differences for objectives
Jonassen (1987)	college	art	30	• prototype only • prototype & practice • prototype, elaboration, practice	• achievement on posttest	• sample size too small for broad conclusions

Principle Investigator	Subjects	Subject Matter	n	Independent Variables	Dependent Variables	Results
Lyness A.L. (1985)	nursing students	CPR	100	• Conventional instruction • Interactive video instruction	• Skill • Knowledge	• no significant differences between traditional CPR and interactive video • interactive video superior for obstructed airways
Malouf (1986)	high school learning disabled	on the job social skills	48	• interactive videotape • workbook • no treatment	• score on criterion reference test	• Interactive videotpe found to be superior to workbook instruction on identical objectives
Phillips (1988)	College	Art	72	• no practice • limited practice • elaborate practice	• retention	• Practice found to be effective at the fact level for repeated items • No significant difference found for practice on unencountered items
Smith (1986)	College	Chemistry	103	• IV lesson only • traditional lab • IV lesson & lab	• grade on lab report • performance on quiz	• IV and IV + lab group scored higher than traditional lab on quiz • iv lab scores were higher than traditional lab reports

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